REPORT NO. 78-2-12

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AN EVALUATION OF INSECT DAMAGE IN SOUTHERN FEDERAL SEED ORCHARDS (1977) (STUART - LA, ERAMBERT - MS, OUACHITA - AR, BEECH CREEK - NC, FRANCIS MARION - SC, AND OCALA - FL)

U. S. FOREST SERVICE
Pineville, Louisiana

U. S. DEPARTMENT OF AGRICULTURE -- FOREST SERVICE
SOUTHEASTERN AREA, STATE AND PRIVATE FORESTRY
RESOURCE PROTECTION UNIT, FOREST INSECT AND DISEASE MANAGEMENT GROUP

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by

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INTRODUCTION

The production of superior seed from pine seed orchards is important in the southern United States because trees from this seed exhibit increased volume growth, improved form and fiber characteristics, and reduced disease incidence. These superior trees are being heavily relied upon to produce increased quantities per unit area of higher quality forest products (FSM 2475.02). Federal seed orchards are just beginning to produce and are being depended upon to regenerate National Forest lands with superior growing stock. Approximately 17,422 pounds of seed are needed annually from southern Federal seed orchards for this purpose.[4/] Only 2,218 pounds of improved seed were produced in 1977.

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4/ Aycock, O. E. and R. E. Major. 1977. A Study of R-8 Seed Processing, Facilities, and Needs. R-8 Report.

Insects are the chief agent causing losses in seed orchards (Overgaard, et al., 1974) and if not controlled, will adversely affect the availability of superior pine seed, thereby reducing future timber production. Currently, there is no technique for predicting population trends of seed orchard insects. Consequently, this evaluation is based on current seed, conelet, and cone damage at the Ouachita, Stuart, Erambert, Francis Marion, Beech Creek, and Ocala Orchards and does not attempt to predict future losses.

Names of principle insect species, description of their biologies and behavior, and damage caused.

CONEWORMS, Dioryctria spp.

Coneworms, Dioryctria amatella (Hulst.), D. clarioralis (Walker), D. new species (abietella group), D. new species (Zimmermani group).

Biologies of coneworms are somewhat similar. Generally these insects attack the flowers, buds, and shoots, as well as the conelets and cones. Damage consists of larval tunnels with partly to totally excavated areas within infested structures (Ebel et al. 1975).

Coneworms, depending on the species, have one to seven generations a year. Young, first instar larvae overwinter and attack flowers and shoots the following spring. Later in the summer, cones are attacked. Some species, like D. amatella, infest fusiform rust, Cronartium fusiforme Hedg. & Hunt, galls and move to cones to complete their development.

PINE SEEDWORMS, Laspeyresia spp.

Three species are prevalent in the South: the slash pine seedworm, L. anaranjada Miller; the longleaf seedworm, L. ingens Heinrich; and the eastern pine seedworm, L. toreuta. Damage consists of larval feeding and development within maturing seeds and cones. Damage from these insects often prevents cones from opening, thereby affecting the extraction of seed.

In general, one generation occurs each year in all species of seedworms. The adults emerge in spring, mate, and the female moth lays eggs on cones. Eggs hatch in 3 to 6 days and young larvae bore into the cones. A larva enters a seed and completely consumes it and then bores into another seed. Each larva destroys one to seven seeds during its development and bores into the cone axis in the fall where it overwinters. The following spring the larva pupates and develops to an adult moth, which emerges through a hole in one of the excavated seeds.

SEEDBUGS, Leptoglossus corculus (Say) and Tetyra bipunctata (H.-S.) These insects are sucking insects which feed upon developing conelets and seeds. Adults are strong fliers and nymphs are highly mobile, feeding on several conelets and cones during their life by puncturing them with their needle-like mouth parts. Early stages are gregarious and may kill conelets and cones. They also puncture developing seeds and destroy the endosperm, causing empty or partially developed seeds.

Leptoglossus corculus overwinters as an adult. Eggs are laid in rows on pine needles. Several generations occur each year. Nymphs or early stages are present from April through October and adults can be found in spring, summer, and fall. In the deep South, the largest populations occur in July and August.

The shieldback bug, T. bipunctata, overwinters as an adult in the litter. This insect has one generation a year. Adult populations may become quite high in late summer and early fall.

NANTUCKET PINE TIP MOTH, Rhyacionia frustrana (Comstock)

Larvae of the Nantucket pine tip moth feed on tips of pines destroying primordial tissue in stems during summer, thus preventing conelet production the following season. They also feed directly on young flowers and conelets in early spring. Severe infestations may greatly retard growth and cause forking of small pine trees. Hosts are shortleaf, Pinus echinata Mill., loblolly, P. taeda L., Virginia, P. virginiana (Mill.), and sand pine, P. clausa (Chapm.) Vasey. Slash pine, P. elliottii Engelm, var. elliottii, can be attacked; however, longleaf pine is resistant to this species of tip moth.

This moth has one to five generations with the most generations occurring in the southern part of its range. Moths emerge in late winter or early spring and lay eggs on new shoots and needles of pines. Upon hatching, larvae feed on young shoots or young

flowers. About the third instar, the larvae bore into shoots where they pupate and complete development.

PINE CONEBORERS, Eucosma spp.

Eucosma cocana Kearfott, E. tocullionana Heinrich.

Damage is similar to that of Dioryctria spp., but the riddled white pine, P. strobus L., and shortleaf pine cones tend to be packed with a mixture of chewings and frass with no obvious tunnel system evident.

These insects usually have one generation a year. Moths emerge from pupae overwintering in the soil about April or May and lay their eggs. Young larvae tend to feed in groups in immature cones and later disperse and become more solitary in infested cones. Although they disperse, the larvae tend to concentrate within major branch systems so damaged cones are noticeably grouped within the tree crown. When mature (June-July), the larvae drop from the cones and pupate in the soil until the following spring.

WHITE PINE CONE BEETLE, Conophthorus coniperda (Schwarts)

The beetles attack the white pine cone at the cone base where it joins the stalk. A doughnut-shaped mass of resin-soaked light brown frass is formed around the entrance hole. Attacked cones wither and die. One insect may attack several cones.

Adult females emerge in early spring and attack and lay eggs in several cones during a 30-day period. The female beetle constructs

a gallery down the cone axis and lays eggs in from one to 24 niches in the gallery wall. The larvae feed on both cone and seed tissues. When cones are scarce, conelets are attacked, but no eggs are laid in them. One generation occurs yearly and adults overwinter in infested cones.

OBJECTIVE

The objective of the insect suppression projects on Federal Seed Orchards is to achieve the specific resource management objectives with the least potential hazard to any nontarget components of the environment.

BIOLOGICAL EVALUATION SURVEY

Cone and conelet loss was determined by tagging 10 percent, or a minimum of 10 clusters, on each sample ramet (1 or 2) of a number of preselected cones (2 to 6) in treated and untreated areas. Monthly observations of individual structures were made throughout the growing season so as to determine time and cause of losses.

Such monitoring studies were as follows:

Orchard	No. of Clones Sampled	Geographical Source	Seed Analysis Used	Treatment
Stuart	6	La. loblolly	SOSET	Furadan® 4 oz/in d.b.h. by fertilizer spreader & disked
	6	La. loblolly	SOSET	Hand treatment 4 oz/in d.b.h.
	6	La. loblolly	SOSET	Check

Erambert	6	So. Miss. loblolly	CAS	Furadan 4 oz/in d.b.h. by Powr-Till Seeder
	6	So. Miss. loblolly	CAS	Furadan 4 oz/in d.b.h. by hand
	6	So. Miss. loblolly	CAS	Untreated check
Ouachita	5	Ozark shortleaf	SOSET	Cygon 2E (1 treatment - April) Guthion® (3 treatments)
	5	Ozark shortleaf	SOSET	DiSyston® 1½ oz/in d.b.h. disked
	5	Ozark shortleaf	SOSET	Check
Francis Marion	4	Loblolly	CAS	Guthion 2S 6 pts/100 gal H_2O (4 sprays)
	4	Loblolly	CAS	Caged - check
	4	Loblolly	CAS	Uncaged - check
Beech Creek	2	Virginia	CAS	Guthion 2S 30 pts/100 gal H_2O (4 sprays)
	2	Virginia	CAS	Caged - check
	2	Virginia	CAS	Uncaged - check
	4	Shortleaf	CAS	Guthion 2S 30 pts/100 gal H_2O (4 sprays)
	4	Shortleaf	CAS	Caged - check
	4	Shortleaf	CAS	Uncaged - check

For CAS analysis, six cones were selected from each ramet. CAS analysis consists of an in-depth analysis of seed potential of cones, number of first and second year aborted ovules, percent sound seed, percent empty seed, percent seedbug and seedworm damage, and percent malformed seed.

For SOSET analysis, bulk samples of 20 to 50 cones were taken from treated and/or untreated areas of other seed sources in each orchard.

SOSET (Seed Orchard Seed Evaluation Testing) data from the Eastern Tree Seed Laboratory, Macon, Georgia, was used to assess damage at the Beech Creek and Francis Marion Orchards. SOSET provides a measure of seed production, viability of the extracted seed, and a radiographic analysis of the extracted seed. The radiographic analysis identifies insect problems, abnormal seed development, and the percentage of filled seed. This method is considered a continual monitoring technique.

A field evaluation using Furadan for seed and cone insect control on sand pine was used for information for a biological evaluation for the Ocala orchard. The orchard was divided into five blocks. One block was left untreated and the other blocks were treated with 2, 4, 6 and 8 ounces of Furadan, respectively.

For the purpose of this evaluation, percent coneworm damage, percent sound seed, sound seeds/cone, and percent seedbug-damaged seed, and percent seedworm damaged seed were assessed.

RESULTS AND DISCUSSION

Stuart Orchard

Coneworm damage

A total of 10 percent of the conelets and 8 percent of the cones were lost due to coneworm attack on a carbofuran (disk) treated area

compared with 23 percent of the conelets and 24 percent of the cones on an untreated area (Table 1). Only conelet losses on the Furadan (disk) treatment were significantly different (5% level) than the check. Also, percent conelet losses due to unknown reasons on the check treatment (34%) were highly significant (1% level) over the carbofuran (disk) treatment (21%). Much of this loss could have been associated with feeding by coneworms and/or other insects.

Seed damage

Percent sound seed ranged from 80 percent in a Furadan-treated area in the Texas loblolly source to 56 percent in a Guthion-treated area in the Texas shortleaf source (Table 2). The Furadan (disk) and Furadan hand treated areas on the Louisiana loblolly source averaged 13 percent more sound seed than the untreated check. This difference, however, was not statistically significant. The number of sound seed per cone in the Furadan disk area was increased by 19 over the uncaged check. This difference was significant at the 5 percent level. The caged check (52 full seeds per cone) and hand treatment (53 full seeds per cone) were each significantly better than the uncaged check (41 full seed per cone) with respect to this variable also. A very small percentage of the seed damage was identified as caused by insects; however, seedbugs probably caused most of the empty seed reported.

Table 1. Coneworm damage at Stuart Orchard, Louisiana, 1977.

Seed Source	Treatment	Percent coneworm damage	
		Conelets	Cones
La. loblolly[1/]	Furadan (disk)[2/]	10.0a[3/]	8.0a
La. loblolly[1/]	Furadan (hand)[4/]	-	16.0a
La. loblolly[1/]	Check	23.0b	24.0b

1/ Sample based on 10 percent of the conelets and cones of each of two ramets of each of six clones and examined monthly.

2/ Furadan (10g) applied by a fertilizer spreader at the rate of 4 ounces per inch d.b.h. and disked to a depth of 3 inches.

3/ Treatment means not followed by the same letter are significantly different from one another at the 5% level of significance.

4/ Furadan (10g) applied by hand shaker and covered with mulch.

Table 2. Analysis of seed collected from the Stuart Orchard, Pollock, Louisiana, 1977.

Geographical Source	Treatment	Percent Full Seed	Percent Empty Seed	No. Full Seeds/cone	Percent Identifiable Insect Damage
Louisiana loblolly[1/]	Furadan (disk)[2/]	69a[3/]	31a	60a	0.4
Louisiana loblolly[1/]	Furadan (hand)[4/]	69a	31a	53a	0.0
Louisiana loblolly[1/]	Check (caged)[5/]	60a	40a	52a	0.3
Louisiana loblolly[1/]	Check (uncaged)	56a	41a	41b	0.3
Texas loblolly[6/]	Furadan (disk)[2/]	80	22	41	2.0
Texas loblolly[6/]	Guthion[7/]	78	21	30	1.0
Texas shortleaf[6/]	Guthion[7/]	56	44	14	0.0
Louisiana shortleaf[6/]	Guthion[7/]	65	35	17	0.0

1/ SOSET analysis of sample of six apparently healthy cones from two ramets of each of six clones by Eastern Tree Seed Laboratory.

2/ Furadan 10 percent granules applied by fertilizer spreader at the rate of 4 ounces per inch tree diameter and disked to a depth of 3 inches.

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

4/ Furadan 10 percent granular insecticide applied by hand shaker and covered with mulch.

5/ Six cones caged with 0.35" mesh aluminum screen in February 1977 and collected from each check sample.

6/ SOSET analysis of a bulk sample of 20 apparently healthy cones.

7/ Guthion 22 percent EC mixed at 16 pints per 100 gallons of water and applied at the rate of 2 gallons per tree by mist blower applicator.

Bulk seed samples from a Furadan (disk) area and Guthion treated area showed a close percentage of sound seed produced between the two; however, the Furadan sample showed an average of nine more seeds per cone than did the Guthion treatment.

Including both increased cone and seed production, it is estimated that 74 percent more sound seed was produced on the Furadan (disk) treated area than the untreated check.

RECOMMENDATIONS

1. Continue spraying with Guthion (30 pints/100 gallons of water of the 22% EC) at 1 gallon /tree with four monthly applications starting in May.

2. The Powr-Till Seeder with the new adaption for use in areas of heavy grass cover should be tested. If it can be used on the orchard, Furadan 10% granular should be applied at the rate of 4 oz per inch of tree d.b.h., except in areas in the Texas shortleaf where FI&DM has the Guthion timing evaluation.

Erambert Orchard

Coneworm damage

The evaluation using the Powr-Till Seeder to apply Furadan granules showed no conelets and 2.9 percent cones damaged by coneworms compared with 1.5 percent conelets and 14.8 percent cones on the untreated check (Table 3). This resulted in an increase of 13.4 percent

Table 3. Coneworm damage at the Erambert Orchard, Mississippi, 1977.

Seed Source	Treatment	Percent coneworm damage	
		Conelets	Cones
So. Mississippi loblolly[1/]	Furadan (Powr-Till Seeder)[2/]	0.0a[3/]	2.9a
So. Mississippi loblolly[1/]	Furadan (hand)[4/]	-	5.0a
So. Mississippi loblolly[1/]	Check	1.5b	14.8b

1/ Sample - 10 percent of conelets and 10 percent of cones tagged on two ramets of each of six clones and examined monthly for damage.

2/ Furadan (10g) applied by means of a John Deere Powr-Till Seeder at the rate of 4 ounces per inch d.b.h.

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

4/ Furadan (10g) applied by hand shaker at the rate of 4 ounces per inch d.b.h. and covered with mulch.

more conelets and cones in the Furadan (Powr-Till treated area) produced over the uncaged check. The above differences were significant at the 5 percent level of confidence.

Seed damage

Percent filled seed in the Furadan (Powr-Till treated area) was only 1.4 percent more than uncaged checks (Table 4). This difference was not statistically significant. However, percent full seed was only 3.9 percent less and numbers of full seed per cone was only 2 less than caged checks. This indicates that seedbug populations were low on this orchard. Identifiable seedbug damage on the Powr-Till treatment was only 0.2 percent less than on the uncaged check.

Seedworm damage was light. No seedworm damage was found on the Powr-Till treated area compared with 1.5 percent on the uncaged check and 0.3 percent on the hand treatment. These differences were not significant.

RECOMMENDATIONS

1. Continue applying Furadan 10% granular at the rate of 4 oz per inch of tree diameter by means of the Powr-Till Seeder in February to seed producing sources.

2. Continue to evaluate 4, 6, and 8 oz of Furadan 10% granular insecticide in the southern Mississippi loblolly source.

Table 4. Insect damaged seed at Erambert Seed Orchard, Brooklyn, Mississippi, 1977.

Geographical Source	Treatment	Percent Full Seed	Percent Empty Seed	No. Full Seeds/cone	Percent Identifiable Seedbug Damaged Seed	Percent Seedworm Damaged Seed
		Powr-Till Seeder Test (CAS)				
So. Miss. loblolly[1/]	Furadan (PT)[2/]	64a[3/]	34a	38a	1a	0a
So. Miss. loblolly[1/]	Furadan (hand)[4/]	66a	33a	40a	2a	0a
So. Miss. loblolly[1/]	Check (caged)[5/]	68a	32a	40a	1a	0a
So. Miss. loblolly[1/]	Check (uncaged)	63a	34a	38a	1a	2a
		Other Samples Analyzed (SOSET)				
Alabama loblolly[6/]	Guthion[7/]	84	15	35	1	0
North Miss. loblolly[6/]	"	74	26	33	0	0
Miss. longleaf[6/]	"	87	11	64	1	1
Alabama slash[6/]	"	84	15	42	1	0
Florida slash[6/]	"	71	28	34	1	0

1/ Sample of six cones from each of two ramets of each of six clones analyzed by CAS by the Eastern Tree Seed Laboratory.

2/ Furadan 10 percent granular applied by the John Deere Powr-Till Seeder at the rate of 4 ounces per inch d.b.h.

3/ Treatment means followed by the same letter are not significant.

4/ Furadan 10 percent granular applied by hand shaker at the rate of 4 ounces per inch of tree d.b.h. and covered with mulch.

5/ Five clusters of cones covered with .35" wire mesh screen on each check ramet.

6/ Bulk sample of 20 cones analyzed by SOSET by FI&DM.

7/ Guthion 22% EC (22 pints per 100 gallons H_2O) applied at 1 gallon per tree by mist blower application.

Ouachita Orchard

Coneworms

Differences in coneworm damage between treatments of Guthion, DiSyston, and check were significant when considering damage to conelets but not to cones (Table 5). Coneworm damage to conelets was as follows: 0 percent on the Guthion treatment, 1.0 percent on the DiSyston treatment, and 8.0 percent on the untreated check. Coneworm damage to cones was 4 percent on the Guthion treatment, 15 percent on the DiSyston treatment and 1 percent on the check. The reason that a significance was not shown for coneworm damage to second year cones was that many of the ramets in the check treatment had completely lost their entire conelet crop the year before; therefore, there was no cone crop on many sample trees and thus, insufficient data to provide a sensitive statistical analysis. Also, because of the light cone crop on the check treatment, in comparison to the other two treatments, coneworms may not have been attracted to the check area. DiSyston has not been tested or registered for coneworm control. It is only registered for tip moth control.

Other damage

Both DiSyston and Guthion significantly reduced conelet losses over the check treatment. Most of these losses were considered to be due to tip moth feeding. Total conelet losses were as follows: DiSyston, 33.7%; Guthion, 30%; and check, 61.8%.

Table 5. Coneworm damage at the Ouachita Orchard, Arkansas, 1977.

Seed Source	Treatment	Percent coneworm damage	
		Conelets	Cones
Ozark shortleaf[1/]	Guthion '76, '77[2/]	0a[3/]	4a
Ozark shortleaf[1/]	DiSyston '76, DiSyston '77[4/]	1a	15a
Ozark shortleaf[1/]	Check	8b	1a

1/ Sample 10 percent of the conelets and cones tagged in February 1976 and followed monthly for a 2-year period until September 1977.

2/ Guthion - applied at 6 pints per 100 gallons of water in 1976 and 30 pints per 100 gallons of water in 1977 at rate of 0.5 gallon water per tree (three applications per year).

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

4/ DiSyston 15 G applied by fertilizer spreader at 2½ ounces per inch tree d.b.h. and disked into the soil (one treatment each in March 1976 and March 1977).

Seed damage

Production of percent full seeds was significantly better on both the Guthion treatment (60%) and the DiSyston treatment (39%) versus the untreated check (3%) (Table 6). Full seeds per cone were as follows: Guthion, 26; DiSyston, 17; untreated check, 1.

The benefits of the treatment came mostly from protection to seeds and conelets. The Guthion treatment appeared to be the best overall treatment with 0 percent conelets infested by coneworms, 4 percent cones infested by coneworms, 30 percent overall losses to conelets and 60 percent full seeds produced.

It is interesting to note, however, as far as percent total losses to the cone crop (conelets and cones) over two 2-year periods (in 1975-76 and 1976-77) there were no significant differences in losses between treatments (Table 7).

RECOMMENDATIONS

1. Continue spraying with Guthion (30 pints/100 gallons of water of 22% EC) at 0.5 gallons/tree with four monthly applications starting in May.

2. The Powr-Till Seeder should be tested for operability on the orchard. If the Powr-Till Seeder is operable, apply Furadan 10g at the rate of 4 oz/in of tree d.b.h.

Table 6. Insect damaged seed at the Ouachita Seed Orchard, Mt. Ida, Arkansas, 1977.

Geographical Source	Treatment	Percent Full Seed	Percent Empty Seed	No. Full Seeds/cone	Percent Identifiable Insect-damaged Seed
		--- Monitoring ---			
Ozark shortleaf[1/]	Guthion[2/]	60a[3/]	40a	26a	0
Ozark shortleaf[1/]	DiSyston[4/]	39a	61a	17a	0
Ozark shortleaf[1/]	Untreated check	3b	97b	1b	0
		--- Bulk samples ---			
West Ouachita[5/]	Guthion[2/]	58	40	36	2
East Ouachita[5/]	Guthion[2/]	66	34	22	0

1/ Sample = six cones from two ramets of three clones analyzed by Eastern Tree Seed Laboratory (SOSET).

2/ Guthion 22% EC, 30 pints per 100 gallons water, applied at ¼ to ½ gallon per tree in four applications (May, June, July, August).

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

4/ Disulfoton 15% granular applied at rate of 2.5 ounces per inch d.b.h. by fertilizer spreader and disked.

5/ Sample = 20 cone bulk sample (SOSET).

Table 7. Percent losses to the cone crop at the Ouachita Orchard during 1975-76 and 1976-77.

Years	Check	DiSyston	Cygon-Guthion
		--- percent ---	
1976 - 77	75.8a[1/]	74.7a	84.3a
1975 - 76	80.6a	61.2a	83.3a

1/ Treatment means not followed by the same letter are significantly different from one another.

Ocala Orchard

Table 8 shows data on insect infestation on the Furadan evaluation which was collected by visually examining each treatment ramet and recording the incident of infestation or damage of aphids, scales, needle gall, webworm, mites, Dioryctria stem attack, and tip moth attack.

Aphids, scales, and tip moth attack were reduced by Furadan treatment. Treatments of 4 to 6 ounces were virtually free from infestation by these insects. Damage to conelets and cones was not evaluated because many of the sample ramets had no conelets or cones.

RECOMMENDATION

1. Apply Furadan at 4 ounce rate to protect 1979 cone crop. The need for this is based on losses commonly experienced in other southern seed orchards. Do not treat FI&DM study trees. FI&DM will repeat the Furadan rate evaluation during 1979.

Beech Creek Orchard

Coneworm damage

No significant difference occurred between Guthion treatments (5.9%) and check treatments (6.3%) as far as coneworm damage to second year cones on Virginia pines in 1977 (Table 9). No loss due to coneworms was observed on either Guthion or check treatments on shortleaf or white pine sources examined.

Table 8. Furadan rate evaluation - Ocala Sand Pine Seed Orchard, April 1978.

Causal Agent	Percent of trees infested[1/] (oz. Furadan/in. of diameter)[2/]				
	Check	2 oz.	4 oz.	6 oz.	8 oz.
Aphids	48.3	0	0	0	0
Scales	8.3	8.3	0	0	0
Dioryctria stem	0	0	8.3	0	0
Tipmoth	13.3	2.1	0	0	0
Tips attacked by tip moth per tree	3.6	2.1	0	0	0

1/ Sample two ramets of each of six clones in each treatment.

2/ Each rate of Furadan 10g applied by hand and raked into the soil.

Table 9. Coneworm damage at the Beech Creek Orchard, North Carolina, 1977.

Seed Source	Treatment	Percent coneworm damage	
		Conelets	Cones
Virginia pine[1/]	Guthion[2/]	-	5.9a[3/]
Virginia pine	Check	-	6.3a
Shortleaf pine	Guthion[2/]	-	0.0
Shortleaf pine	Check	-	0.0

1/ Sample 10 percent of the cones of two ramets of each of four clones followed monthly March 1977 - September 1977.

2/ Guthion 22% EC applied at the rate of 30 pints per 100 gallons water (1 gallon per tree).

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

Seed Damage

As a whole, more sound seed was produced on treated trees than on uncaged checks at the Beech Creek Orchard (Table 10). Fifteen percent and 19 percent more sound seed was harvested from shortleaf pine on the Guthion treatment and caged checks, respectively, than from uncaged checks; however, these differences were not significant. No significant difference occurred between means of Guthion treatments and caged check treatments. Sixty-four percent more sound seed was produced on Guthion treated Virginia pine than on uncaged checks. This difference was significant at the 5% level. No significant difference was found between Guthion treatments and caged check treatments.

For bulk samples analyzed by SOSET analysis, only 6 percent more sound seed was produced on the Furadan treatment than on uncaged checks on white pines. Twenty-six and 46 percent more sound seed was produced on two other Guthion treated shortleaf and Virginia pine seed sources, respectively, than on untreated checks. These differences were not analyzed statistically.

Other Insect Damage

On rate studies during 1978 using a check treatment and 4 and 8 ounce treatments of Furadan per inch of tree diameter on white pine, both the 4 ounce and 8 ounce rates showed significantly fewer losses (1% level) due to coneborer and cone beetle attack than the check (Table 11). There was no significant difference between the 4 and 8 ounce treatments with respects these damage categories. Both treatments also showed significantly (1% level) greater percent healthy cones than the check.

Table 10. Analysis of seed collected from Beech Creek Orchard, North Carolina, 1977.

Geographical Source	Treatment	Percent Full Seeds	Percent Empty Seeds	Percent Identifiable Seedbug damage	Percent Seedworm Damage
Shortleaf[1/]	Guthion[2/]	64a[3/]	35a	0.1a	0.5a
"	Caged check[4/]	68a	31a	0.1a	0.0a
"	Uncaged check	49a	50a	0.1a	0.3a
Virginia pine[1/]	Guthion[2/]	86a	13a	0.1a	0.5a
"	Caged check[4/]	82a	18a	0.0a	0.4a
"	Uncaged check	22b	76b	1.1a	0.5a
White pine[5/]	Furadan[6/]	82	16	0.3	0.0
"	Uncaged check	76	19	0.5	0.0
Shortleaf[5/]	Guthion	75	20	0.0	0.0
"	Uncaged check	49	46	0.0	0.0
Virginia pine[5/]	Guthion	75	20	0.0	0.0
	Uncaged check	29	71	0.0	0.0

1/ Data based on CAS analysis by the Eastern Tree Seed Laboratory of extracted seed from six cones taken from each of one to three ramets of each of four clones.

2/ Guthion (22% EC) mixed at the rate of 30 pints per 100 gallons of water and sprayed by mist blower.

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of confidence.

4/ Five cones caged with 0.35" mesh aluminum screen on each untreated check tree.

5/ Data based on seed extracted from a bulk sample of 20 cones analyzed by SOSET analysis by the Eastern Tree Seed Laboratory.

6/ Furadan (10% granular) applied at the rate of 8 ounces per inch d.b.h. by hand shaker and scratched in.

Table 11. Furadan rate evaluation on white pine at the Beech Creek Seed Orchard, North Carolina, 1978.

Causal Agent or condition	Treatment[1] (percent)		
	Check	Furadan 10g oz/in d.b.h.[2]	Furadan 10g 8 oz/in d.b.h
Coneborer	16a[3]	0b	0b
Conebeetle	11a	6b	1b
Healthy cones	66a	93b	97b

1/ Sample = 10 percent of the cones tagged on two ramets of each of six clones on each treatment and examined monthly.

2/ Furadan 10g applied by Powr-Till Seeder.

3/ Treatment means not followed by the same letter are significantly different from one another.

RECOMMENDATIONS

1. Apply Furadan 10% granular at the rate of 4 ounces per inch of d.b.h. by means of the Powr-Till Seeder to seed producing sources in February.

2. Include treatment areas in the most important seed source of check, 6 and 8 ounces for comparison with the above treatment.

Francis Marion

Coneworm damage

For coneworm losses on loblolly pine, the difference between means of the check treatment (30%) and Guthion treatment (3%) were significicant at the 1 percent level (Table 12).

Seed Damage

On the average, Guthion treated loblolly pines contained 16 and 14 percent more sound seed respectively than the caged and uncaged checks; however, these differences were not significant (Table 13). Guthion treatments contained 9 and 11 percent less empty seed respectively than caged and uncaged checks. These differences were also insignficant. Identifiable seedbug and seedworm damage was light in all treatments. Seedworm damage was significantly less (5% level) in each the Guthion treatment and caged checks than in the uncaged checks.

Table 12. Coneworm damage at the Francis Marion Orchard, South Carolina, 1977.

Seed Source	Treatment	Percent coneworm damage	
		Conelets	Cones
Loblolly[1/]	Guthion[2/]	-	3.0a[3/]
Loblolly[1/]	Check	-	41.0b

1/ Guthion 22% EC applied at the rate of 6 pints per 100 gallons of water (approximately 2 gallons per tree) applied by mist blower.

2/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of significance.

3/ Sample 10 percent of the conelets and cones tagged in March 1977 on two ramets of each of four clones and followed monthly until September 1977.

Table 13. Analysis of seed collected from the Francis Marion Orchard, South Carolina, 1977.

Geographical Source	Treatment	Percent Full Seeds	Percent Empty Seeds	Percent Identifiable Seedbug Damage	Percent Seedworm Damage
Loblolly[1/]	Guthion[2/]	57a[3/]	40a	0.4a	0.0a
	Caged check[4/]	41a	49a	0.1a	0.0a
	Uncaged check	43a	51a	1.1a	0.5b

1/ Five cones taken from two ramets of each of four clones in each treatment and subjected to CAS analysis.

2/ Guthion (22% EC) (6 pints mixed with 100 gallons H_2O) applied by mist blower at the rate of 2 gallons per tree.

3/ Treatment means not followed by the same letter are significantly different from one another at the 5 percent level of confidence.

4/ Five cones caged with 0.35" mesh aluminum screen on each untreated check ramet.

RECOMMENDATIONS

1. Apply Furadan 10% granular at the rate of 4 ounces per inch d.b.h. by means of the Powr-Till Seeder to producing seed sources in February.

2. Include treatment areas in the most important seed source of a check, 6 ounce, and 8 ounce treatments.

GENERAL DISCUSSION

Results of suppression projects varied considerably as to coneworm damage. Some areas, like Virginia pine at the Beech Creek orchard, showed no significance between treatments (Guthion vs. check); however, other areas showed a highly significant difference between treatments as with the loblolly source at the Francis Marion Orchard (Guthion vs. check).

As far as seed yield, most treatments on most seed sources assessed showed an increase over untreated checks. However, some treatments, as with Furadan on Southern Mississippi loblolly at the Erambert Orchard, did not show a marked increase in percent sound seed as compared with check treatments. However, Guthion sprayed at the Ouachita showed a marked and statistically significant increase in seed yield over the check (60 percent sound seed on the Guthion treatment vs. 3 percent sound seed on the check).

The reason suppression results were not consistent as far as coneworm damage or full seed produced was probably due to the fact that insect populations were low on some orchards, thereby not showing large differences between check and treatment damages. Also, only four clones and two ramets per clone were used on some areas with some of the sample ramets missing as on the Beech Creek and Francis Marion Orchards. This did not provide for a sensitive statistical test. Also, SOSET analysis is based only on seeds that shake out freely. Some clones or even ramets within clones contain cones that are slower to mature. Therefore, some samples collected too early did not produce a great quantity of sound seed because cones did not open fully and not because of lack of insect control.

Appraisal of current significance

Populations of seed and cone insects in southern Federal Seed Orchards were not generally high during 1977. Coneworm losses varied from a high of 41 percent on loblolly at the Francis Marion Orchard to no detectable infestation on shortleaf and white pines at the Beech Creek Orchard. Seedbug populations were not high as reflected by the relatively high percentages of full seed present in check treatments, except for the shortleaf check at the Ouachita Orchard (3% full seed) and Virginia pine at the Beech Creek (22% sound seed).

Appraisal of potential significance

The reproduction potential of each insect species involved is not known. Any one species is capable of causing serious losses in any given year and losses exceeding 90 percent of the possible seed crop are not unusual (Overgaard et al. 1975).

Course of the outbreak if unchecked

The course of the outbreak if left unchecked is unknown. Populations of the different species of insects affecting pine seed production fluctuate considerably from year to year according to climatic conditions and parasite-predator populations. However, it is known that serious losses will continue unless checked.

Course of the outbreak if checked

Although excessive seed and cone losses will be prevented by treatments during the year of application, continued treatment will be needed from year to year due to rapid buildup of insect populations in the orchard and reinfestation of populations from wild pine stands.

GENERAL RECOMMENDATIONS

1. Use minimal effective dosage rates of registered insecticides.

2. Provide monitoring of the fate of insecticides in the environment when there is a potential for adverse environment effects or there is a public controversy.

3. Additional research is needed on procedures to predict population trends and to determine the need for or against control based on sampling populations during the season.

4. Research needs to be conducted on integrated pest management techniques applicable to pine seed orchards.

5. A post-suppression analysis needs to be conducted to determine the actual benefit/cost for the Federal seed orchard spray projects.

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